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The 'active state' during contracture of the frog's rectus. By
 W. D. M. PATON. *Department of Pharmacology, Royal College of Surgeons
 Examination Hall, Queen Square, London, W.C.1*

It was noticed, during experiments on the frog's rectus using the 'pendulum' lever (Paton, 1957), that acetylcholine reduced the extensibility of the muscle. This suggested that acetylcholine produced in the muscle a state corresponding to the 'active state' described by Hill (1949), during propagated responses in frog sartorius.

The rectus was immersed in modified Ringer's solution (NaCl, 6 g; KCl, 0.15 g; $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$, 0.3 g; NaHCO_3 , 0.5 g; water, 1000 ml.) bubbled with 5% CO_2 /95% O_2 . Its lower end was attached to the bottom of the 4 ml. bath which

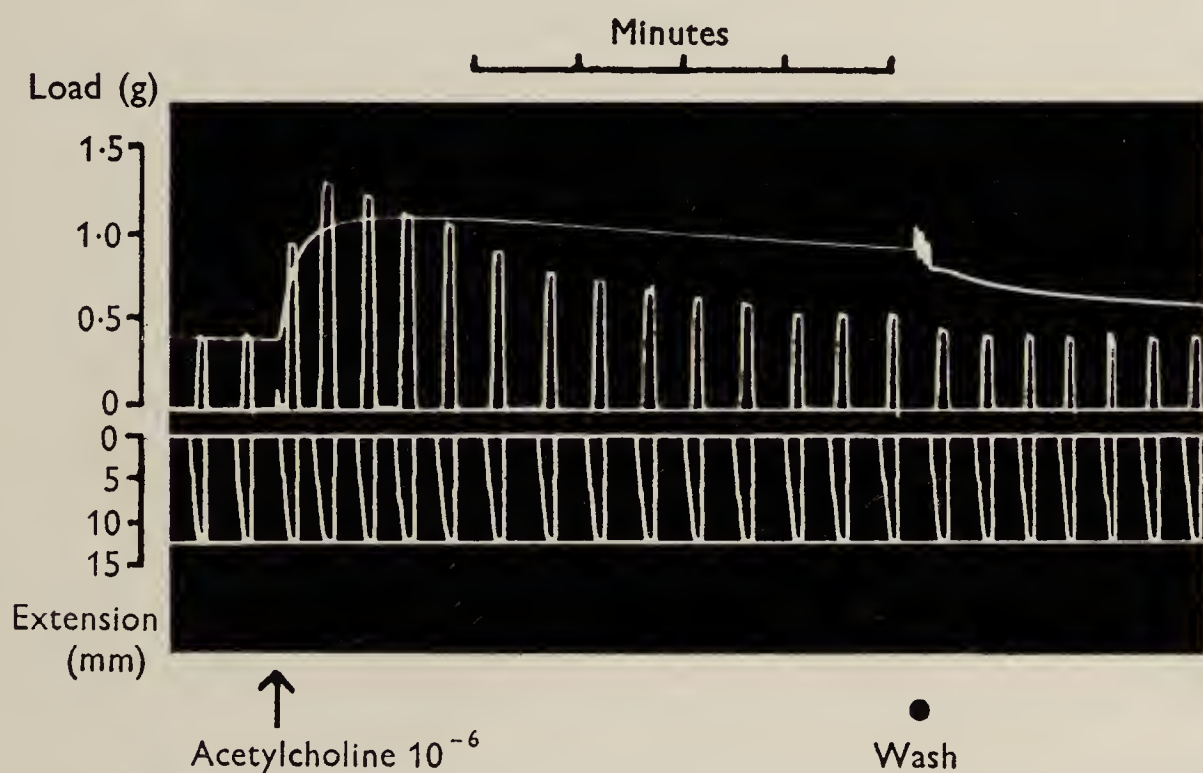


Fig. 1. Frog's rectus abdominis. Upper part of tracing: superimposed responses to acetylcholine 10^{-6} recorded (a) as a continuous contraction, (b) as tension developed to repeated stretch from a state of zero tension. Lower part of tracing: record of movement of the bath, by which the muscle was stretched either (a) continuously, or (b) intermittently. The actual extension of the muscle is less than that shown by this record, by $1/8.5 \times$ the excursion of the pendulum lever.

was carried on a calibrated rack and pinion, thus allowing the muscle to be stretched. Its upper end was attached to a pendulum lever, magnification 8.5, load 500 mg/cm deflexion on the smoked drum.

Fig. 1 contrasts the effects of acetylcholine (a) recorded as a continuous contraction, and (b) recorded in response to repeated brief extensions. Two differences appear: (1) the onset and offset of action are much quicker when detected by response to stretch; (2) the stretch experiment reveals a peak and subsequent decline, which are obscured with the conventional method.

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If, when the action of acetylcholine is developed at a given length, the tension is lowered by raising the bath slightly, the muscle then shortens and re-develops tension. Comparison of this curve of re-establishment of tension with the curve of tension development when acetylcholine is first added provides an estimate of the drug's diffusion time. Diffusion could account for the delay in development of inextensibility, in which case the full 'active state' due to acetylcholine is set up very quickly.

A dose-response curve for compliance changes due to acetylcholine can be constructed. If this is compared with the curve for depolarization of frog sartorius by acetylcholine obtained by Fatt (1950), the two dose-response curves are approximately parallel. This suggests that the 'active state' developed during acetylcholine contracture is roughly proportional to the membrane depolarization.

REFERENCES

- Fatt, P. (1950). *J. Physiol.* **111**, 408-422.
Hill, A. V. (1949). *Proc. Roy. Soc. B*, **136**, 399-420.
Paton, W. D. M. (1957). *J. Physiol.* **137**, 35 P.